Television Consumption Drives Perceptions of Female Body Attractiveness in a Population Undergoing Technological Transition

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Abstract

Perceptions of physical attractiveness vary across cultural groups, particularly for female body size and shape. It has been hypothesised that visual media propagates Western 'thin ideals'. However, because cross-cultural studies typically consider groups highly differentiated on a number of factors, identifying the causal factors has thus far been impossible. In the present research, we conducted 'naturalistic' and controlled experiments to test the influence of media access on female body ideals in a remote region of Nicaragua by sampling from villages with and without regular television access. We found that greater television consumption remained a significant predictor of preferences for slimmer, curvier female figures after controlling for a range of other factors in an ethnically balanced sample of 299 individuals (150 female, aged 15-79) across 7 villages. Within-individual analyses in one village over 3 years also showed an association between increased TV consumption and preferences for slimmer figures amongst some participants. Finally, an experimental study in two low-media locations demonstrates that exposure to media images of fashion models can directly impact participants' body size ideals. We thus provide the first converging cross-sectional, longitudinal and experimental evidence from field-based research, that media exposure can drive changes in perceptions of female attractiveness.

Keywords: attractiveness; BMI; waist-hip ratio; Miskitu; Mestizo; Garifuna; Creole; body ideals; media; thin ideal; television; Nicaragua

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A critical argument in studies of human interpersonal attraction, is the extent to which the traits we consider attractive are culturally specific versus 'universal'. While there is considerable cross-cultural agreement on some aspects of attractiveness, other preferences such as body weight ideals show striking cross-cultural variation (e.g., Ember, Ember, Korotayev & de Munck, 2005; Swami et al., 2010) even within otherwise similar populations (Tovée, Swami, Furnham, & Mangalparsad, 2006). While some authors have attempted to argue that cross-cultural variation may be driven by population differences in access to food resources (Swami & Tovée, 2006), others have highlighted the potential role of media in spreading a Western 'thin ideal' for women (Becker, Burwell, Gilman, Herzog, & Hamburg, 2002; Stice, Spangler, & Agras, 2001; Swami et al., 2010). Isolating such factors, however, is extremely challenging in cross-cultural research as they are typically strongly correlated across populations. The research on which the current paper is based took advantage of a remarkable field site to conduct naturalistic experiments into how cultural factors, in particular television access, may drive changes in perceptions of attractiveness, specifically for female body size and shape.

Ecological models of variation in body ideals.

Evolutionary theorists have suggested that interpersonal attraction may function in part to identify the most advantageous social and intimate partners for a given ecological niche (e.g., Gangestad, Haselton & Buss, 2006). As such cultural variation in perceptions of attractiveness may derive from underlying 'conditional' adaptations expressing themselves differently in different ecological circumstances. For instance, multiple studies relying on aggregated group/state level data have found that pathogen prevalence is associated with

prioritisation of features such as general attractiveness, masculinity and good health, which are hypothesised to indicate underlying immunity (see e.g., DeBruine et al., 2010, 2011; Gangestad et al, 2006; White et al., 2013) - although we note that such studies often fail to control for geographical or cultural clustering in the data. Resource and food scarcity have been posited as potentially important predictors of attitudes to body weight, reflecting an adaptation to ecological circumstances. Consistent with this model, cross-cultural studies have found that populations in nations with lower development indices tend to favour higher body weight than industrialised populations, (Ember et al., 2005; Swami et al., 2010). Within populations, socioeconomic status may negatively predict preferences for weight in male bodies (Lee et al., 2015), and hunger predicts preferences for heavier weight and shape in female bodies (Swami & Tovée, 2006, 2013). There is also evidence that pathogen cues and pathogen sensitivity may affect individual preferences for weight and shape in faces and bodies (Fisher et al., 2013; Lee et al., 2015).

An ecological approach to body weight ideals suggests that low (vs. high) levels of resources (economic or nutritional) trigger greater interest in indicators that an individual is buffered against such shortages, including body fat. However, Jucker et al. (2017) failed to support this view when investigating the detailed nutritional profiles of residents in three neighbouring Nicaraguan villages which differed from each other in nutritional resources. No measure of nutritional stress predicted preferences for female body weight once village-level clustering and control variables such as acculturation and income were accounted for, which presented a surprising challenge to the ecological approach to body ideals.

Visual culture models of body ideals

In contrast, other research has highlighted the potential for visual culture, particularly modern mass media, to drive variation between groups in physical ideals in a manner which may be independent of, or even at odds with, ecologically-driven ideals. Historical evidence shows, for instance, that depictions of female body shape (specifically waist-hip ratio) in European art remained constant throughout the classical and medieval period but became increasingly curvy in the early modern period in a manner which coincides with technological developments in shape-altering undergarments (Bovet & Raymond, 2015).

Visual media may be a particularly strong form of cultural influence for two reasons. Firstly, due to underlying plasticity in the way our brains encode bodies and faces, it is possible to manipulate adults' attraction preferences by simple visual exposure to adjusted stimuli (a psychophysiological process known as adaptation). Observers will typically prefer stimuli which have the same manipulation (e.g., feature expansion, identity manipulation or size changes) as those to which they have experienced prolonged exposure (faces: Anzures, Mondloch, & Lackner, 2009; Bestelmeyer et al., 2008; Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003; bodies: Boothroyd, Tovée, & Pollet, 2012; Hummel, Grabhorn, & Mohr, 2012; Winkler & Rhodes, 2005). As such, repeated exposure to bodies of a particular type (e.g., corseted as in Bovet and Raymond's study, or low-weight, as in much modern media) should shift preferences within the population in that direction.

Secondly, associative learning can also shape preferences, by classical conditioning (e.g., pairing faces with aversive noise blasts: Jones, DeBruine, Little, & Feinberg, 2007), and potentially by associating features with more abstract, desired traits (e.g., presenting aspirational versus neutrally valenced figures: Boothroyd et al., 2012). Not only does mass media contain a rarefied, unrepresentative selection of visual stimuli (i.e. the majority of actors, presenters and models tend to be unusually attractive by typical Western standards), but some physical traits tend to be further associated in media with positive representation, such as higher status (e.g., thinness: Voracek & Fisher, 2002, 2006; fairness of complexion: Ashikari, 2005). This combination of opportunities for both visual adaptation and associative learning effects should therefore lead to media influence on general population preferences.

While some have argued that associative learning may complement evolutionary processes, such as assisting us in learning local cues of good health, good nutrition and status (Tovée et al., 2006), the generalised nature of these processes means that visual media may, at least in the short-term, have the capacity to push preferences away from evolutionary fitness optima (see e.g., Stephen & Perera, 2014).

Documented variation in body preferences between and within cultures

Most studies of cultural variation in body ideals to date are unable to effectively tease apart ecological and media influences. For instance, Swami et al. (2010) conducted a large cross-cultural comparison of body size preferences, and found that samples with higher access to Western media showed preferences for thinner female bodies, and that urban samples preferred slimmer bodies than rural samples in two Middle-Income countries (Malaysia and South Africa). The substantial ecological differences between countries and between these urban and rural populations (e.g., in subsistence, income and pathogen risk), however, could also plausibly explain the differences in body ideals. Indeed this is likely why no such difference in body ideals was observed between urban and rural Austrians in the same study.

In a related study, Zulu migrants to the UK showed preferences for body shape and body size which were closer to the preferences of White and Afro-Caribbean Britons than to Zulus remaining in South Africa (Tovée et al., 2006), although their preferences remained significantly different from the British preferences. The authors suggested that whereas in South Africa lower body weight is a cue to poverty and poor health (Clark, Niccolai, Kissinger, Peterson, & Bouvier, 1999; Kotler & Grunfeld, 1995; Mvo, Dick, & Steyn, 1999), migrants to the UK become exposed to a culture in which *high* weight is deemed to indicate poor health and lower socioeconomic status (Darmon, Ferguson, & Briend, 2002; James, Nelson, Ralph, & Leather, 1997) and thinness is promoted in the media. Thus, via a valence learning mechanism, they may have adapted their perceptions of attractiveness to the new cultural input. However, there were similar differences in ecology between the South African-based and the UK-based samples in this study to those in Swami et al.'s work (e.g., in terms of human development indices, subsistence, pathogen prevalence, and inequality). Furthermore, sampling was cross-sectional: migrants may already have had more Westernised preferences, and their Western-like preferences may have contributed to their migration rather than resulted from it.

A small number of studies have examined body shape preferences in small-scale, traditional societies with low levels of contact with mass media. For instance, Wetsman & Marlowe (2001) found that Hadza hunter-gatherers had no preference for more vs less curvy figures while Americans had a strong preference for images of women with a narrow waist. More recently, Sorokowski & Sorokowska (2012) found that men amongst the Yali of Papua preferred a smaller waist in female figures if they lived nearer to the city. Finally, when a modest sample of male participants from the Nicaraguan fieldsite used in the present work were asked to create their own 'ideal woman' using avatar software, those who reported watching more Western media preferred a more 'Western' body shape (smaller lower body, and larger chest; Thornborrow, Jucker, Boothroyd & Tovée, 2018). In all these cases however, cultural factors and ecology remain confounded; those groups or individuals with more access to Western culture also had higher incomes or more reliable nutrition or were generally higher on human development indices.

The best test of whether media is indeed responsible for global shifts in body ideals is to examine static, non-Western populations in which ecology remains stable while media access is variable. Such populations are, however, extraordinarily rare. To our knowledge the only previous study to consider body ideals which matches these criteria are the data of Becker et al. (2002; Becker, 2004), who examined eating attitudes in Fijian teenagers both when television was first introduced to the region, and (in a separate cohort) two years later. Analyses showed that pathological eating attitudes increased significantly between cohorts and more relevant to our study, the teenagers reported in interviews that they were experiencing increasing desire for a slimmer body which was at odds with the high-weight ideals prevalent in that culture. Although Becker's work is more relevant to one's own body image (rather than third-party perceptions of attractiveness), these qualitative data support the suggestion that media can induce changes in body preferences in previously unexposed populations, and highlight the need for quantitative investigation.

The current studies

The aim of the studies presented here was to comprehensively test the hypothesis that visual culture impacts perceptions of female body attractiveness in a rapidly developing population. As we note above, such a test requires a stable population with minimal ecological variation, but considerable variation between individuals or over time in access to visual media. We built a uniquely rich dataset, incorporating both between- and within-individual variation, through long term fieldwork in the South Caribbean Coast Autonomous Region of Nicaragua. Thanks to ongoing government development programs, this area of Nicaragua has become subject to an extraordinary natural experiment in media access. Populations in this area do not have access to magazines and until very recently (often after we had finished data collection in their communities, see below) had no access to the internet except when visiting large towns. For the vast majority of inhabitants, access to visual media has been exclusively through television – both broadcast and satellite media, and DVDs. Only those with electricity supplies to their homes or villages, as well as the money to buy a television and pay subscriptions, are able to access these on a regular basis, however. As such, television consumption is, for most participants in this location, a clear measure of their total current exposure to visual media.

In the last decade, the government has been extending the electricity grid across the remoter rural areas of the region such that it becomes possible to compare individuals living in very similar, geographically close communities where the primary difference is that some villages have electricity (and thereby, access to television) while others do not. Studies 1 and 2 therefore consider cross-sectional and within-individual analyses, respectively, of the association between television consumption and body shape preferences in the region, while Study 3 gives complementary experimental evidence of visual media impact in the field. These studies will thus yield converging evidence regarding the impact of television on beauty ideals in a 'non-WEIRD' population (i.e. a population not meeting the criteria which exemplify the vast majority of research

participants in the behavioral sciences: Western, Educated, Industrialised, Rich and Democratic; Henrich, Heine, & Norenzayan, 2010).

Leveraging cultural differences to test experimental claims is an underused tool in experimental Social Psychology. Doing so, however, enables us to generate evidence regarding cultural influences on psychology which is highly ecologically valid while still facilitating causal inference. Similarly, controlled experiments run in 'non-WEIRD', small scale societies are extraordinarily rare in Psychology despite the fact that such studies are vital to understanding whether models of psychological processes developed on Western or other industrialised samples generalise beyond our evolutionarily-novel environments (see e.g., Apicella et al, 2018, on contagion sensitivity). Where our work takes an entirely novel step forward, however, is in combining these two approaches within one population.

Testing body weight preferences.

Our research considered two aspects of body ideals: body mass scaled for height, and body shape. Body mass was indexed by the Body Mass Index or BMI. This is calculated as weight in kg divided by the square of height in metres. For European populations, a healthy BMI is typically between 18.5 and 25 kg/m^2 but most European and European-descent populations prefer bodies at the lower end of this range. Obesity is considered to be a BMI of 30 or above. For non-White populations, the health problems associated with obesity may present themselves at a lower BMI point than in White populations. However, in populations with recurrent nutritional stress (as many of our participants experience: Jucker et al., 2017; see also Study 2 of the current paper) higher BMI allows buffering against periods of hunger (see e.g., Prentice and Jebb, 2004, for discussion). As such, for the majority of our participants, their 'most healthy' BMI is likely to be at the upper end of the standard healthy range, and well above the ideal presented in mass media.

Ideal body size has been assessed in a number of ways. The most common assessment is through figural scales (Gardner & Brown, 2010a; Jones et al., 2018). These are usually 8-10 line drawn figures standing in front-view, varying in apparent body weight from thin to obese. The participant chooses his or her ideal from these alternatives. This method has two obvious problems. Firstly, the bodies are not biometrically calibrated to real BMI values and secondly, they only sample the BMI spectrum very coarsely. As a result, it is not possible to say what the ideal is with any precision. To counter the first of these problems, some studies have used photographs of people of a known BMI, so that a participant's choice can be related to real world preferences (e.g., Swami et al. 2012). But for a more precise estimate of the ideal, it is necessary to increase the number of bodies used in the assessment to provide a finer sampling of the BMI dimension. In this context, rather than ask a participant to choose their ideal body from a much larger set, all the images are rated for attractiveness and then analysis of these ratings extracts the participant's ideal body size and shape (e.g., Tovée, Maisey, Emery, & Cornelissen, 1999; Tovée, Reinhardt, Emery, & Cornelissen, 1998). Typically, BMI preferences in female stimuli are best described by a cubic function which allows for a sharp increase in attractiveness ratings from emaciated to mildly underweight/healthy bodies, followed by a slower decline in attractiveness ratings after that point (i.e. preferences are asymmetric around the apex and thus not suited to, for instance, quadratic functions). Furthermore, cubic models can equally well describe preferences of some non-Western participants (e.g., those in South Africa: Tovée et al, 2006, and Nicaragua as below) whose attractiveness ratings are even more asymmetric and typically stay high for overweight and even obese bodies. This is a robust procedure, the results of which do not seem to be skewed by the relative ranges of shape and size in the image sets (Tovée et al., 2017; for further discussion see Boothroyd et al., 2018).

An alternative option is to use an interactive method of adjustment paradigm, where participants can alter the size of a body along the BMI dimension (Evans et al., 2013; Gardner & Brown., 2010b; Tovée et al., 2001). This limits the range of information which can be extracted from responses to that one dimension but allows for a fine sampling of the body size and is quicker and simpler for the participant to complete. Furthermore, body size perceptions using such interactive techniques show good validity against measures based on participants choosing their ideal from a range of static images (Gardner & Brown., 2010b). Similarly experimental adaptation studies using interactive tasks (e.g., Sturman et al, 2017) have been shown to produce concordant results to those in which participants rate a number of images as above (e.g., Glauert et al, 2009) with considerably fewer trials. In this project we use both a rating paradigm with a large photographic set (Studies 1 & 2) and a method of adjustment paradigm using an interactive body adjustment program (Study 3).

Testing body shape preferences.

Studies 1 and 2 also looked at preferences for measures of body shape using the rating paradigm, specifically by considering the waist-hip ratio (WHR: waist circumference divided by hip circumference) and waist-chest ratio (WCR: waist circumference divided by bust circumference) of the stimuli. Considering body shape allows us to examine aspects of body attractiveness that go beyond simple weight and incorporate topography. Previous research on body shape preferences has found cultural variation using simple line

drawings (Wetsman & Marlow, 2001), with computer-generated body silhouettes (Sorokowski & Sorokowska, 2012) and by allowing participants to alter body shape of images, akin to the method-of adjustment paradigm (Thornborrow et al., 2018). All these methods tend to alter body weight alongside body shape (because, for example, the waist may become smaller while the hips remain the same size). However, by considering how body shape affects preferences for real bodies while statistically controlling for the weight of those stimuli, we can more accurately assess the independent contribution of shape to preferences. Unlike body weight preferences, preferences for WHR tend to be linear, with smaller waists being considered more attractive and no drop-off in attractiveness within the natural range of female body shape. This is the method we utilised to examine body shape preferences in Studies 1 and 2.

Hypotheses.

If the hypothesis that visual media directly affect body ideals cross-culturally is correct, we should see that those with greater television consumption (i.e. the greatest amount of visual media consumption) in our sample should have the most 'Western' body ideals: preferring lower overall body weight and smaller waists relative to hips and bust. Furthermore, potential confounds such as other routes for cultural transmission (broader social acculturation and education) and resource availability (wealth and hunger) should not explain any such association. Likewise, when individuals' access to visual media (indexed by television consumption) changes over time such that individuals with generally low access are temporarily or lastingly able to consume more television, the visual culture account of body ideals would predict their preferences should also change between time points in a more Western direction. Finally, if it is the *visual* content of visual media which is inducing such effects, experimental exposure to images of high or low weight women which represent those utilised in globalised mass media (i.e. aspirational, attractive exemplars), would affect the preferences of participants with low media consumption in a similar manner. Our studies addressed each of these predictions in turn.

The study site

Our research was primarily focused on the Pearl Lagoon Basin and surrounding area. This area is ethnically diverse; our participants were predominantly Creole, Garifuna (a linguistic/ethnic group with significant African ancestry, speaking Nicaraguan Creole English), Mestizo (Spanish speakers of predominantly European ancestry) and Miskitu (known locally as 'Indians', with their own distinct language; Jamieson, 2003). Although there is considerable apparent admixture between the Creoles, Garifuna, Miskitu, and other indigenous ethnicities, there remains a sharper (but not impermeable) cultural boundary between these groups and Mestizos (see e.g. Jamieson, 2010, for further discussion); indeed many Mestizos in the area are comparatively recent first or second generation migrants from central or Western regions of Nicaragua.

The residents of the villages studied subsist mainly on small scale agriculture, animal husbandry and fishing (for those living on the Lagoon coastline). Turtle hunting, catching shrimp and lobster in the open sea can also provide intermittent nutrition or cash income. A proportion of residents in the more accessible villages have more substantial integration into the cash economy, for instance running boarding houses, working in construction, paid work on ranches, running a small retail shop or 'venta', or involvement in the tourist industry (e.g., tour guides). Furthermore, some men (although none of our participants) travel to work on cruise ships for periods of up to a year, which can yield a significant source of cash for use in major investments (e.g., building a cement house or buying a boat with engine). A small number may be involved in education (primary or secondary school teachers) or working in modern industries in larger towns (e.g., road construction or other manual labour).

Although the Miskitu are traditionally matrilocal with bride service marriages (Jamieson, 2003), increased integration with other ethnic groups, such as the Garifuna and Creoles, has resulted in mixed kinship and marriage models, and we observed a high rate of serial monogamy. Marriages between Mestizos, however, were more likely to be monogamous 'nuclear' families. Of those aged over 18 in our sample, 45% were currently cohabiting (married or, more often, living together as if married), and 81% had children. Residents of the region have access to medical clinics for routine healthcare, and the contraceptive injection is available to most women in the area. Despite this, fertility rates are high, with a modal average of 6 children per woman (based on participants aged over 40; absolute range: 0 to 13 children per woman).

The studied villages.

Demographic information on each participating village is given in Table 1 below. We recruited participants in two Miskitu villages (M1 and M2), two Mestizo villages (S1 and S2), and three Garifuna villages

(C1, C2 and C3). We attempted to locate relatively 'higher' and 'lower' media-access villages within each ethnic group. We summarise below the subsistence base and the electricity and media access for each village.

M1 is located on the Rio Grande just to the North of the lagoon and the population subsists on farming. Although there was one small solar panel present during data collection, the rest of the village had no electricity access and no televisions. Mobile phones had no signal in the village, although some men had phones they use when visiting larger communities. In contrast, M2, a community of c. 740 residents on the Lagoon coast, acquired mains electricity in 2008 (by 2017 85% of households had electricity installed in a census by author JLJ) and by 2014 televisions were commonplace although not ubiquitous. No participants had smartphones at the time of data collection in 2014. M2 had also had a small high school since 2011, whereas M1 only had elementary education in the village.

S1 and S2 are both located up river from the Lagoon and subsist on animal husbandry and small scale arable crops. At the time of our first data collection in 2015, four households in S1 had a small solar panel which provided limited access to television for a small number of villagers, whereas S2 had had a community generator since 2009 which provided regular electricity and television access for most villagers. There was no mobile phone signal in S1 but mobile phones were used (with good signal) in S2 and smart phones were observed from our first visit onwards.

Table 1. Profile of villages utilised across all studies. For clarity, villages have been anonymised with a letter code indicating the dominant language in the village (M = Miskitu, C = Creole English, S = Spanish) and number, where higher numbers within each letter code indicate greater TV consumption within the village.

	M1	M2[a]	C1[a,b]	C2[b]	C3[b]	S1	S2
Tested	2016	2014	2014, 15, 17	2015	2015	2015,17	2015, 17
Location	Rio Grande	Lagoon coast	Lagoon coast	Lagoon coast	Lagoon coast	Riverside	Riverside
Dominant language	Miskitu	Miskitu/Creole	Creole/Spanish	Creole	Creole	Spanish	Spanish
Primary Subsistence	Farming	Farming/Fish	Farming/Fish	Farming/Fish	Paid work, Farming, Fish	Farming	Farming
Electricity (year of installation)	1 solar panel	Mains (2008)	1 solar panel (2015)	Mains (2009)	Community generator (2007)	Some solar/ Mains (2016)	Community generator (2009)
Total N	37	66	51	40	42	41	40
% Female	51.4	60.6	40.8	45.0	47.6	51.2	50.0
Mean age	31.2	24.7	29.0	35.1	27.4	28.2	28.9
Ethnicities[1]:							
% Creole	0	14	22	63	21	0	3
% Garifuna	0	2	53	55	95	0	8
% Mestizo	14	8	27	0	0	100	98
% Miskito	92	95	6	18	12	0	0
% Other	5	0	4	8	0	0	0
Acculturation	1.67	1.86	2.47	1.76	1.73	3.70	3.50
Income $/annum	498.17	373.10	302.05	1269.09	1172.96	957.58	1156.07
Mean education (yrs)	4.6	8.8	5.4	8.1	9.6	4.6	6.4
Mean hunger[2]	4.5	4.9	4.8	4.4	4.9	4.6	4.7
Mean hrs since last meal	3.8	3.1	4.4	4.3	3.6	4.7	3.8
% TV access[3]	18.9	98.5	10.2	100.0	100.0	70.7	90.0
Mean hrs TV last 7 days	0.4	13.5	1.9	12.2	15.4	5.1	10.8

1. including where participants reported multiple categories; 2. 1=starving to 10=bursting; 3. at home or a house they sometimes visit. a. 2014 data reported by Boothroyd et al., 2016; b. Data reported by Jucker et al., 2017

C1 is a small Garifuna farming and fishing community of currently c. 40 individuals on the Lagoon coast with Mestizo homesteads (approximately a further 15-20 residents) scattered around it. At the time of data collection for Study 1, there was no source of electricity and no televisions in the village. C2 is a similar nearby

Garifuna community of currently about 60-80 permanent residents (based on our observation), which received mains electricity in 2009 (6 years before data collection) and features a beach-side bar serving a small number of occasional tourists. C1 had a very small elementary school while C2 also catered to high school students. Mobile signal in both C1 and C2 was weak throughout our time in the field (sufficient for text but not for downloading images) and to our knowledge none of our participants had smart phones until after data collection finished. Finally, C3 is a larger Lagoon community, which has had a community generator providing reliable electricity for most of the day since 2009. Although some residents had smart phones during data collection, signal was too weak for downloading media in the village. Some men reported downloading Caribbean music videos (which did not typically show the thin ideal) and pornography ('pron') when visiting larger towns. At the time of testing, C3 was the only community with a semi-regular (twice weekly) 'panga' boat link to the regional capital.

For comparison purposes, figures in Study 1 also include data from a sample gathered in the national capital Managua in 2014 (used in analyses by Boothroyd et al, 2016). These individuals were recruited through snowball sampling in Campo Bruce - a working class barrio which is representative of the majority of the city. All Managuan participants had daily access to television and reported having access to television for as long as they could remember. They were also all regular users of internet cafés.

Across all our communities, those who watched television reported favouring Latin American soap operas known as *telenovelas*, Hollywood action movies (known as 'van Dammes' or 'fighting pictures'), music videos, police 'car chase' reality shows, and the news. A small number of participants also reported watching religious services on television. The only differences in television preferences we observed across locations was an interest in Black Caribbean content in C3, particularly music videos. These videos were the only television content we observed in which the women featured were likely to deviate from the typical Western 'thin ideal' or the Latin American trend for 'thin and curvy' actresses in *telenovelas*.

Study 1 – The cross-sectional association of television exposure with body ideals

As discussed above, a strong test of whether visual media changes body preferences is to consider the association between media access/consumption and preferences in populations in which media access is relatively novel and where there are not strong differences between participants in other relevant variables such as nutrition, income, subsistence or education. Prominent quantitative studies on culture and body ideals to date have been limited by the use of migrant populations without considering baseline pre-migratory characteristics (Tovée et al., 2006) and/or have utilised populations with more divergent profiles than simply media access (e.g., Swami et al., 2010). The aim of Study 1 was therefore to run a large cross-sectional study in a limited geographical region where media access varies and where other confounding variables can be controlled.

Two previous studies in this region have compared a single low-TV village with one or two villages with established electricity and television access. Both studies found that participants in the low-TV access village exhibited preferences for larger figures than those in the high-TV access village, although the control urban sample in the capital Managua preferred the thinnest bodies of all (Boothroyd et al., 2016; Jucker et al., 2017). There were a number of weaknesses in these comparisons, however. Firstly, the villages studied differed in more than just their television access despite being similarly geographically placed. The villages with electricity were usually larger, inhabitants had a higher income on average, had eaten more recently and in Boothroyd et al. (2016) had a different ethnic profile compared to the village without electricity. Furthermore, because of multicollinearity between village and television access it was impossible to use village as a dummy variable alongside television consumption in regression analyses in the first study (Boothroyd et al., 2016). Thus, although the data were highly suggestive of a significant link between television access and female body size preferences (even after controlling for acculturation, income, education, and time since last meal), it was impossible to rule out unmeasured additional factors acting at the level of village.

Furthermore, these earlier studies only examined one aspect of body ideals, namely overall BMI, without considering body shape. Study 1 therefore, compared individuals on their body size and shape ideals across all seven villages including both high and low media locations with populations drawn from the four main ethnic groups. Using data from seven villages allows use of multilevel models to examine individual level variance while appropriately accounting for village level variance (Gelman & Hill, 2007), and to more robustly test our hypothesis that television consumption will be associated with an increased preference for slim bodies. The data utilised here includes those previously collected from four communities by Boothroyd et al. (2016) (C1, M2) and Jucker et al. (2017) (C2, C3) with additional data from a further three communities (M1, S1, S2). Where participants were involved in more than one of these studies or participated on more than one occasion, only data from their first participation is included in Study 1.

As well as the previously utilised outcome variable of BMI preference, we also extracted preferences for body shape in terms of waist to hip (WHR) and waist to bust (WCR) ratios. Potential confounding variables assessed remained the same as in previous studies: socio-linguistic acculturation (the extent to which participants thought, spoke, read and socialised in or with the 'acculturated' language/group, where we specified 'Spanish or US English' as the acculturated category), education (which is another aspect of broader acculturation), income, and two measures of hunger.

Participants

314 individuals aged 15 to 79 were recruited from seven villages, as summarised in Table 1. Participants were selected through opportunity sampling and word of mouth. We aimed for 40 individuals (20m, 20f) in each village based on a previous study which found significant results with samples of 35 and above (Tovée et al., 2006). An additional 25 were tested in M2 for participation in an additional study. Where there were insufficient individuals to reach this target, we recruited every available adult in the village. Participants under 16 or over 75 were tested with a guardian present. Participants were tested individually in a quiet room in their home village and were paid $4 in local currency. Fifty-eight percent (n = 183) of the participants were interviewed and took the test in Creole English, and 42% (n = 132) in Spanish. Methods and procedures were approved by Department of Psychology Ethics Committee, reference: 13/17.

Questionnaire measures

Participants first completed a verbal questionnaire in which they reported the following:

Ethnicity. Participants initially reported their ethnicity using the categories: Garifuna, Mestizo, Miskitu, Sumu, Ulwa or Other, based on pilot data. Participants reporting 'other' gave details of their ethnic identification. However, only three participants reported Sumu or Ulwa ethnicity in our final sample, while the majority of those reporting 'other' considered themselves to be Creole or some combination of our other categories. Participants were therefore assigned dummy variable scores indicating whether or not they identified with each of: Creole, Garifuna, Mestizo, Miskitu, or another ethnicity. All participants thus had at least one, and sometimes two ethnicities indicated in this manner.

Acculturation. Participants completed an adapted version of the Self-Identity Acculturation Scale (Cuellar, Harris, & Jasso, 1980; Suinn, Rickard-Figueroa, Lew, & Vigil, 1987), in which they reported the frequency with which they spoke or thought in US English or Spanish (versus Creole or Miskitu), and the proportion of their friends/preferred social network who were primarily Spanish or US English speaking versus Miskitu or Creole. Participants responded on 1-5 Likert scales where 5 indicated always speaking/thinking/socialising in the acculturated language(s) and scores were averaged across all 11 items. Mean acculturation score was 2.35 (SD = .91; range = 1-4.33). However, because acculturation was observed to be strongly bimodal, and to be essentially a proxy for Mestizo ethnicity (r = .902) it was not analysed further.

Education. Participants indicated their highest level of education and total years of education. Twelve percent (n = 39) of participants reported that they had received no formal education, 31% had attended some, or completed, primary education, and 41% had attended some secondary education. Fifteen percent had completed secondary education or more. The average number of years of education by participant was 6.94 (SD = 4.19; range: 0-18).

Income. Participants reported their cash earnings in the last year in Nicaraguan Cordobas or US Dollars. For analysis, all earnings were converted into US Dollars at 28 NIC/$. Average income was equivalent to $772.66 pa ($SD$ = 112.70; range: 0-6 429).

Hunger. Participants reported their subjective level of hunger on a Likert scale from 1 (starving) to 10 (bursting), and the time in hours since their last meal. The average number of hours since the participants' last meal was 3.90 (SD = 2.93; range: 0-20). Responses on the hunger scale typically did not range outside of 4-6 and so we did not use this measure in analyses.

Television exposure. Participants reported whether they had access to television (in their own home or in a friend's home they visit) and how many hours of television they had watched in the last 7 days. 71.1 % (n = 224) of the participants had a television in their house or in a neighbour's house that they visit sometimes. The participants reported watching television for an average of 8.87 hours (SD = 8.83; range: 0-49) in the 7 days before taking part in the experiment. Because TV consumption was highly skewed (skew: 16.91), the natural logarithm of hours watched was used in the analyses as per Boothroyd et al. (2016), with original values of zero mapped onto zero in the transformed data, resulting in elimination of the skew (-.005). For more details of skew on other questionnaire measures see Supplementary Information.

Body preference task

Participants then completed the *Body weight preference task*, in which participants rated the attractiveness of 50 colour, front-view photographs of women of known BMI (ranging 11-42) and body proportions on a Likert scale from 1 (in Creole English, *very bad body*/in Spanish, *muy poco atractivo*) to 5 (*very good body*/*muy atractivo*) (Tovée et al., 1999; Tovée et al., 1998). All stimuli showed White British women wearing plain grey leotards in a standard arms-out pose, against a standardised dark grey background, with faces obscured.

Figure 1. Sample stimuli showing images from across the BMI range.

Images were presented in a random order on a laptop screen and participants verbally reported their rating. Participants were told that we were interested in their personal opinion and that there were no "right or wrong" answers. As most participants were not familiar with Likert scales, target question and scale were repeated for each figure, and the experimenter would check that the participants used the scale appropriately (for example: "You gave a 3 to the previous body, and a 4 to the current body. So this means that you find the current body a bit more attractive than the previous body, correct?") Eight participants ceased testing during the preference task when it became clear they did not understand how to use the scale after 10 trials. Such participants would typically keep referring to the health of the stimuli rather than their attractiveness, would give all stimuli the same score despite claiming to like some more than others, or would repeatedly ask the experimenter if they had given the 'right' score. Participants with whom we ceased testing or whose data were later excluded for nonviable functions were predominantly from village C1, but also included participants from C2, M2 and S1.

Three scores were derived from the body ratings. Peak BMI preference was calculated by fitting a cubic regression function onto each participant's preference ratings and the BMI of each image in Microsoft Excel using the LINEST function; peak BMI represents the BMI value predicted by the apex in the function – that is, the BMI score a body would have to achieve the highest predicted preference rating by that participant. Where the Excel calculations of peak preference returned a BMI value outside the range of 17.1 to 32.0 or an 'error', that participant's data were visually inspected. Participants whose plotted data showed a linear positive association between BMI and attraction, were assigned a preference of BMI 40 (i.e. a score near the upper boundary of the available stimuli). Where visual inspection showed no discernible association between BMI and attractiveness ratings, that participant was assigned a 'missing' value (6 participants; see Supplementary Information for example plots).

Preferences for WHR and WCR were estimated based on the linear relationship between attractiveness and body shape and indicate how much an individual's preference ratings change as stimuli become less curvy. However, because both WCR and WHR are partly explained by BMI, it was also necessary to control for image

BMI. We therefore used standardised residuals for each image, derived from the linear regression between BMI and WHR/WCR in these images, to generate WHR and WCR values controlling for BMI. The attractiveness scores given by participants to each image were then regressed onto (BMI-controlled) WHR or WCR using LINEST in Excel, and we extracted the resulting linear regression slope. Thus WCR and WHR preference slopes represent the participant's preference for body curviness, controlling for body BMI.

Analyses

Data were analysed in R version 3.3.3 (R Development Core Team). ANCOVAs to compare village level differences were conducted using the *lm* and *anova* summary functions (Bates, Maechler, Bolker, & Walker, 2015); correlations between predictor, control and outcome variables were run using the *rcorr* function in the *Hmisc* package (Harrell, 2006), and multilevel random intercept regression models to assess the impact of television on body ideals across individuals were run in the *lme4* package (Bates et al., 2015) and compiled in *stargazer* (Hlavac, 2018), with beta weights and R^2 calculated in *Sjplot* (Lüdecke, 2019). Figures were produced using *ggplot2* (Wickham, 2009).

Analyses were planned and pre-registered after completion of data collection (https://osf.io/49rkc/register/565fb3678c5e4a66b5582f67; Research Questions 1 and 2).

Results

Initial ANCOVAs [village (7 levels) x sex (2 levels) x age (covariate)] were run to test whether putatively high-TV villages had differing preferences to low-TV villages. Age was included as a covariate due to the differences between villages in participant age (see Table 1). Results showed significant differences across villages for both peak BMI preference ($F_{6,284} = 8.631$, $p < .001$) and WHR preference ($F_{6,284} = 5.226$, $p < .001$). Post-hoc tests demonstrated that inhabitants of villages M1 (very low media, Miskitu village), C1 (very low media, Garifuna/Mestizo village), and C2 (media for 6 years, Garifuna village) preferred significantly larger bodies on average than those living in the other four villages (all Tukey's $p < .05$), while inhabitants of villages M1 and C1 showed a less negative association between WHR and attractiveness – i.e. they were less interested in a small waist/curvy figure than those in other villages (all Tukey's $p < .05$). Overall patterns of preferences are shown in Figure 2, which gives the functions for each village based on the mean rating of each stimulus in that village.

Table 2. ANCOVA results for comparisons between villages, controlling for sex and age, on body preferences.

		F	*df*	*p*	*Eta²*
Peak BMI preference					
	Sex	2.96	1,284	.09	0.01
	Village	8.63	6,284	<.00	0.15
	Age	2.15	1,284	.14	0.01
	Village x Sex	2.15	6,284	.05	0.04
WHR					
	Sex	0.19	1,284	.67	<0.00
	Village	5.23	6,284	<.00	0.01
	Age	4.86	1,284	.03	0.01
	Village x Sex	1.00	6,284	.43	0.01
WCR					
	Sex	0.50	1,284	.37	<0.00
	Village	0.56	6,284	.76	0.01
	Age	3.01	1,284	.08	0.01
	Village x Sex	0.50	6,284	.81	0.01

There was a significant interaction between sex and village ($F_{6,284} = 2.152$, $p = .048$); additional ANCOVAs for each village with age and sex as predictors showed that women preferred larger bodies than men in C2 ($F_{1,35} = 9.233$, $p = .004$) but no sex differences in any other village (all $F < 2.3$, all $p > 0.1$). There was also a significant association between age and WHR preference such that older participants had a less negative slope ($F_{1,35} = 4.865$, $p = .028$). There were no significant or borderline results for WCR except for a borderline association with age (all $F < 1$, *all* $p > .3$; *see* Table 2 for values).

Zero order correlations examining the predictor and control variables' associations with body preferences showed that Age, Education and TV consumption were all significantly associated with BMI and WHR preferences such that older participants and those with less education, or who watched less television, preferred larger and less curvy bodies. Education was also associated with WCR such that those with more education preferred curvier figures. Values can be seen in Table 3. Although there were no other significant correlations, given the borderline interaction between village and sex for BMI preferences, exploratory

correlations were run separately for men and women for BMI preference. These analyses yielded qualitatively identical results to the main correlations.

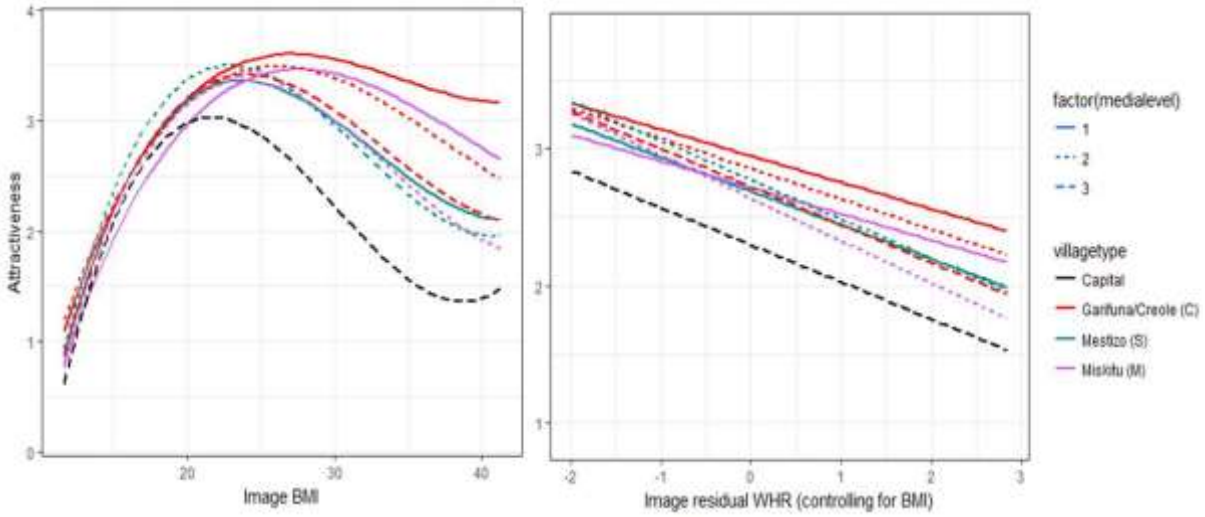

Figure 2. Preference functions for BMI (left) and WHR (right) in each village. Solid lines represent the village with least media access and long dashes the villages with most access within each linguistic group. Data from the capital Managua (taken from Boothroyd et al., 2016) are shown in black.

Table 3. Zero-order correlations (with p values) between predictor and control variables, and body preferences, across all participants. N=299

	peak BMI preference		WHR preference slope		WCR preference slope	
	r	*p*	*r*	*p*	*r*	*p*
WHR preference slope	.44	<.00				
WCR preference slope	.07	.20	.30	<.00		
Age	.13	.02	.16	.01	.09	.12
Education (years)	-.22	<.00	-.30	<.00	-.18	<.00
Income ($)	-.08	.21	-.08	.13	-.07	.23
Hours since last meal	-.03	.66	-.04	.49	-.10	.08
Ln(hours of TV)	-.24	<.00	-.26	<.00	-.03	.51

To examine whether TV consumption was a significant predictor of preferences once village groupings and other covariates were taken into account, multilevel models were constructed for both BMI and WHR preferences. Given the lack of association between WCR preference slopes and either village or any of the covariates except education, this outcome variable was not examined further. Random intercept multilevel models were run with participants nested within village, using restricted maximum likelihood estimation. Variance partitioning in the null models, suggested village could be ascribed 14.6% of variance in BMI preferences, and 9.1% of variance in WHR preference slopes. Analyses then proceeded by putting participant demographic characteristics into the model first (age, sex and ethnicity), followed by TV consumption (our predictor of interest), followed by education (i.e. the only control variable significant correlating with body preferences, as per our preregistered plan of analysis). All covariates were at participant-level in the analysis and uncentred. Models for both peak BMI preferences and WHR preference slopes are shown in Table 4 below. (Note that these models included random intercepts but not random slopes; adding random slopes for TV consumption and Education did not significantly improve models; mixed chi-square Likelihood ratio test gave p = .344 for BMI preference and .295 for WHR preference slope.)

Sex and ethnicity both significantly predicted peak BMI preference as did television consumption and education. Thus, in the final model, we observe that women prefer significantly larger figures than men, that participants reporting Mestizo ethnicity prefer significantly slimmer figures than participants who do not report Mestizo ethnicity (by approximately 2.5 BMI points), and that greater levels of television consumption and education are associated with a preference for thinner bodies. Increasing television consumption from 0-1 hours a week to approximately 3.4 hours a week, was predicted to reduce body size preferences by a whole BMI point (with further increases having a reduced impact due to the logarithmic scale). Four years of education was predicted to have a similar impact.

For WHR preference slope, none of the core participant characteristics significantly predicted slope. Only television consumption and education showed a significant association, such that those who watched more television and were more educated had more negative slopes, i.e., they preferred curvier figures.

Interim discussion

Our key prediction was that increased access to, and consumption of, visual media through television would be associated cross-sectionally with a preference for slimmer bodies. We built on our previous studies (Boothroyd et al., 2016; Jucker et al., 2017) by collecting a significantly larger sample, incorporating high and low media villages within each of three main ethnic groups, and including more measures of body ideals. Initial analyses, in which participants were compared by village, partially supported our predictions in that the two villages with the least media access showed larger body preferences than all but one other village. Although Village C2, in which there had been mains electricity and regular television access for 6 years, showed body ideals equivalent to those seen in nearby Village C1 where there is no regular television access, it is worth noting that the present study included both Mestizo and Garifuna participants in village C1, but there is no such Mestizo minority in C2. In our previous study comparing Garifuna and Creole participants only in these locations, there was a significant difference as predicted (Jucker et al., 2017).

Table 4. Regression coefficients (with S.E.) for multilevel models of body size and shape preferences. N=299

	B	*SE*	*ß*	*B*	*SE*	*ß*	*B*	*SE*	*ß*
Peak BMI Preference									
Intercept	24.86	1.31	0.00	26.89	1.28	0.00	28.87	1.34	0.00
Age	0.03	0.02	0.08	0.02	0.02	0.06	0.00	0.02	0.01
Sex	1.18*	0.51	0.13	1.05	0.51*	0.11	1.03*	0.50	0.11
Ethnicity:									
Mestizo	-1.50	1.08	-0.15	-2.10*	1.00	-0.21	-2.49**	0.96	-0.25
Miskitu	-0.45	0.99	-0.05	-0.50	0.90	-0.05	-0.44	0.87	-0.04
Garifuna	1.03	1.01	0.10	0.90	0.94	0.09	1.03	0.91	0.10
Creole	1.15	0.88	0.09	1.16	0.84	0.09	1.29	0.82	0.10
Other	1.40	1.87	0.04	1.74	1.85	0.05	2.27	1.83	0.07
Ln(TV)				-0.93***	0.26	-0.24	-0.71**	0.26	-0.18
Education							-0.25**	0.07	-0.22
Random Effects									
Residual	19.1			19.02			18.42		
Village	2.97			0.63			0.34		
Marginal / Conditional R^2	0.081 / 0.204			0.130 / 0.158			0.173 / 0.188		
LogLikelihood	-865.628			-862.034			-858.001		
WHR preference slope									
Intercept	-21.09	3.21	0.00	-16.28	3.22	0.00	-11.02	3.4	0.00
Age	0.13*	0.06	0.13	0.10	0.06	0.10	0.04	0.06	0.04
Sex	0.12	1.31	0.00	-0.20	1.30	-0.01	-0.23	1.27	-0.01
Ethnicity:									
Mestizo	-0.74	2.7	-0.03	-2.12	2.50	-0.09	-3.04	2.44	-0.12
Miskitu	-0.59	2.48	-0.02	-0.93	2.27	-0.04	-0.78	2.20	-0.03
Garifuna	-0.64	2.53	-0.03	-0.37	2.37	-0.01	0.24	2.30	0.01
Creole	1.51	2.21	0.05	1.82	2.13	0.06	2.24	2.07	0.07
Other	3.08	4.76	0.04	3.76	4.72	0.05	5.1	4.63	0.06
Ln(TV)				-2.25***	0.64	-0.24	-1.43*	0.66	-0.15
Education							-0.71***	0.18	-0.25
Random Effects									
Residual	124.82			123.46			117.98		
Village	12.8			3.11			2.46		

Marginal / Conditional R^2	0.024 / 0.115	0.080 / 0.103	0.129 / 0.147
LogLikelihood	-1,137.84	-1,132.94	-1,126.45

Indeed, in our multilevel analyses, all indigenous and Creole groups preferred significantly larger figures than Mestizo participants. This may be because Mestizos are culturally more European than other groups in the region (for instance, in our interactions they displayed much more knowledge of European history and culture than other participants), and as discussed above, were more likely to be first or second generation migrants to the Caribbean coast. As such some Mestizo participants may have experienced more media access in younger years or may have had parents who transmitted a preference for slimmer figures through other means. Once variation due to ethnicity was controlled, however, we saw a significant association between recent TV consumption and body ideals. Those who had watched more television in the last week preferred slimmer and curvier figures. We also found that years of education was similarly associated with a preference for slimmer and curvier figures. Although educational materials we observed in the villages did not include many images, content was often biased towards European or North American perspectives or focused on the priorities of policy makers in Managua (the majority of the curriculum is centrally determined). School-based education has been historically used to actively 'de-culturize' colonised nations (see e.g., Spring 2012 for discussion) and has been implicated in cultural homogenisation at a global level (see e.g., Dale, 2005). Furthermore, those who completed higher levels of education (high school for some villages and, rarely, college/university) had to study in larger towns and as such, likely had more extensive exposure to globalised media and culture in younger years.

Importantly, these results are broadly consistent with our previous analyses of a smaller sample which also found that both TV consumption and education were associated with a preference for slimmer female bodies in C1 and M2 (Boothroyd et al., 2016), and suggest that those earlier results were not simply due to unmeasured village-level factors creating the appearance of an association at the individual level.

We note that in contrast to BMI and WHR preferences, we did not find an association between television exposure and preferences for a curvy upper body. Furthermore, although WCR preference slopes were correlated with WHR preference slopes, they were not associated with BMI preferences. This may in part reflect local attitudes which emphasise the lower body in judging attractiveness. Our participants in this study and related qualitative research generally did not express interest in breasts as an aesthetic or sexual feature of women's bodies, and tended to admire female celebrities known for their large bottoms rather than their breasts (e.g., Nicky Minaj; see Thornborrow et al., 2018, for further discussion). Thus although television may induce a preference for small waists, participants may have been less likely to attend to the breasts in media imagery.

Study 2: Associations within-individuals between television on body shape preferences

A key weakness of Study 1 is that it is cross-sectional, and we are thus unable to demonstrate change (or lack of change) in body ideals following changes in exposure to visual media. Residents of the region are generally unable to control whether or not they have *regular* access to television per se, since it involves requiring regular predictable electricity supplies, or travel to larger communities which is expensive and is undertaken only when necessity dictates it, for example, for work, family, or health reasons. However, of those who have a television in their own home, individuals may be more likely to actively seek out and view more appearance-focused content if they already prefer the ideals presented in globalised media. As such some proportion of the variance in our data may be subject to pre-existing individual differences. Study 2 therefore collected data at multiple timepoints to investigate the link between recent television exposure and body ideals *within* individuals.

At the commencement of our research programme, electricity supplies were planned for installation in village S1 and we therefore planned to use this as a model of longitudinal change. However, installation was repeatedly delayed and opportunities to revisit after installation were limited by the end of the grant; as a result participant retention was unacceptably low in S1 (N=12) and its ethnically matched comparator village S2 (N = 22). Furthermore, those individuals re-tested in S1 were predominantly those who previously had regular television access via solar panel. Our attempts to recruit additional participants who had acquired televisions following village-wide installation was likewise hampered. As such, S1 offered minimal opportunity to test our predictions.

On the other hand, village C1 did present an opportunistic opening for our research. Individuals in C1 had originally been tested in 2014 (for Study 1) and in 2015 (for Jucker et al., 2017). In April 2017, we retested these individuals a third time, and had acceptable retention across these timepoints with 31 participants tested at

least twice. Despite the lack of mains electricity, residents of C1 did show within individual variability in their television access, either through travel to other communities or because there was briefly a television in the village. During our 2015 data collection (but not 2014), one household had access to a small solar panel that was used to provide lighting to two houses and, when possible, to power a small television (without cable or satellite) and a DVD player, on which one of a dozen DVDs was occasionally played. These DVDs were a low-quality, mix of Hollywood action films and films that are colloquially known as 'Black people pictures', and which do not typically feature the thin ideal. By 2017, this television was no longer used, due to technical problems with the solar panel, efforts to save electricity to charge mobile phones, and a lack of new DVDs.

We therefore predicted i. that those individuals who watched more television at one timepoint versus another would likewise prefer thinner bodies at that time point versus another, and ii. that the use by some individuals of a television in 2015 would lead to preferences that year being significantly slimmer than at other time points. (For additional analyses of S1 and S2 data, see supplementary materials.)

Methods and results

In total, 31 individuals were tested on at least two occasions in C1 (15 were tested three times). Demographic breakdown of the sample across time points is shown in Table 5 below.

Table 5. Numbers, demographics and preferences scores Village C1 at each time point for repeat-participants (SD given in brackets)..

	2014	2015	2017
% Female	45	48	44
N	31	29	16
Age	30.87 (14.9)	31.41 (14.5)	31.94 (16.7)
TV (hrs last 7 days)	1.74 (3.0)	2.20 (3.0)	1.38 (7.18)
Peak BMI preference	29.23 (6.0)	28.55 (6.2)	30.39 (7.4)
WHR preference slope*100	-11.95 (11.1)	-8.85 (8.3)	-14.19 (9.8)

Participants completed the body preference task and reported hours of TV watched in the last 7 days at each time point. As before, hours of TV were analysed using a Log transform. Peak BMI preference and WHR preference slope were also both calculated as before, with data which failed to show a viable function excluded. Three individuals were removed from within-participant analyses due to producing only one viable preference function, while four of those tested on three occasions had their data from one timepoint excluded. WCR preference slopes were not analysed given the lack of significant results in Study 1. Data were analysed using random intercept models with maximum likelihood estimation, via the *lme4* package in R and compiled using *stargazer* and *SjPlot*, as in Study 1, to firstly compare mean preferences across timepoints, and then compare the relationship between television and preferences across timepoints within individuals.

Comparisons between timepoints were assessed using a random intercept multilevel model, to account for the incomplete participation at each point. Datapoints were clustered within participants and time (year) was added as a datapoint level predictor. Results showed no significant association between time and preferences except for a trend for larger bodies to be preferred in 2017 than in 2015 (see Table 6).

Table 6. Models of the association between testing time and body size/shape preferences in village C1

	BMI preference			WHR preference		
	B	*SE*	*ß*	*B*	*SE*	*ß*
Constant	28.51***	-1.21		-10.76***	1.94	
Time (ref: 2015)						
2014	0.88	-1.20	0.08	-1.46	2.23	-0.06
2017	2.78†	-1.471	0.19	-2.94	2.71	-0.13
Random effects:						
Individual	20.21			29.14		
Residual	17.97			63.66		
Marginal / Conditional R^2	0.028 / 0.544			0.012 / 0.325		
Log Likelihood	-219.685			-255.545		

To assess the association between TV and BMI preference within individuals, TV consumption was centred within individuals. Random intercept models were then constructed with datapoints nested within individuals. Preference score was entered as the outcome variable, TV consumption was entered as a fixed effect, followed by ethnicity (dummy variable for Mestizo or not) and the interaction in a second model. Results are shown in Table 7. There was a negative association between TV and BMI preference which was marginal in the first model but significant in the second model once ethnicity was included, indicating the effect may exist primarily amongst the non-Mestizo villagers (although we note the interaction term was not significant.) As shown in Figure 3, at timepoints when they had watched more television, individuals tended to have body preferences which were thinner than at timepoints where they watched less television. (See supplementary RMarkdown output for alternate earlier analyses of this data, which had less conservative results). There were no significant effects for WHR in any models.

Table 7. Fixed effect estimates (with SE) for associations between TV consumption centred within individuals and body preferences. † p = .067 * p < .05

	BMI preference						WHR preference slope					
	B	*SE*	*ß*	*B*	*SE*	*ß*	*B*	*SE*	*ß*	*B*	*SE*	*ß*
Constant	29.66	0.99		30.44	1.10		-11.85	1.45		-11.42	1.67	
TV consumption	-1.58†	0.86	-0.15	-2.38*	1.04	-0.23	1.61	1.59	0.10	2.29	1.95	0.14
Ethnicity				-3.18	2.21	-0.21				-1.69	3.36	-0.07
TV x ethnicity				2.38	1.79	0.13				1.97	3.35	-0.07
Random effects:												
Individual	19.52			17.73			32.14			31.89		
Residual	18.54			17.84			63.23			62.65		
Marginal/ Conditional R^2	0.024 / 0.525			0.085 / 0.541			0.010 / 0.344			0.019 / 0.350		
Loglikelihood	-210.357			-208.493			-245.043			-244.745		

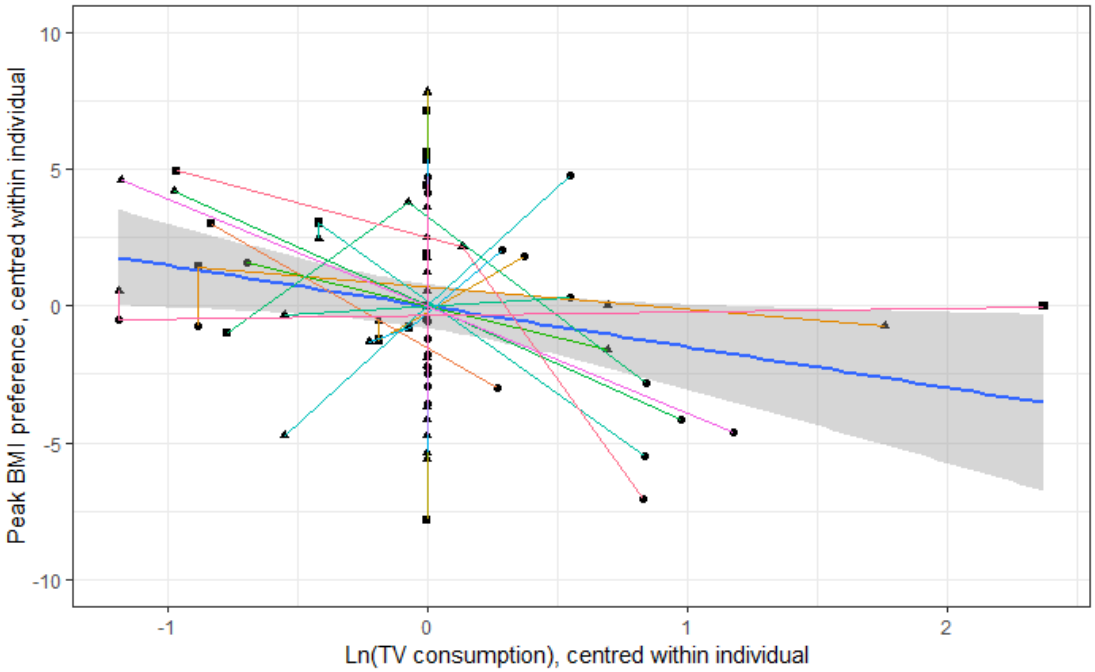

Figure 3. Spaghetti plot showing association between within-individual variance in TV consumption and peak BMI preference in village C1, with linear regression line and standard error shown. Note for visualisation, BMI preferences are also centred within individual. Circles indicate 2014 data, triangles indicate 2015 and squares indicate 2017.

Interim Discussion

These results suggest that within-individual variation in TV consumption was associated with within-individual variation in body size (but not shape) ideals, at least amongst the non-Mestizo (predominantly Garifuna) residents in C1. Some inhabitants had temporary access to DVD content around 2015; otherwise participants in this location are only able to access television when visiting nearby communities with mains

electricity. As such any impact of recent TV consumption amongst these participants are against a background of very low television access. These data would therefore suggest that television may have a direct impact on body size ideals within individuals, as well as between individual in Study 1.

The trend for a change in preferences between 2015 to 2017 may possibly reflect changes in nutritional status between those years as many of our participants and contacts in the area reported experiencing a poor year for fish, and our participants in Village C1 had lost weight between 2015 and 2017 (mean loss: 1.53kg, t = 3.983, p = .001 – excluding pregnant women; we did not weigh participants in 2014). However, given that this result was only marginal in C1 (albeit significant in supplementary analyses including S1 and S2, see below), and we have very low power for 2017, we simply raise this point to suggest more research on periods of actual scarcity may possibly be warranted.

Indeed, our sample size is a concern for Study 2 in general and the poor participant retention in S1 meant that opportunities to test our core hypothesis were limited to C1. Although supplementary analyses of the data we did gather in S1 and S2 showed no association between television consumption and body ideals for those participants, our numbers in these locations were even smaller than in C1 (only 12 in S1). Furthermore, those participants we retained were all habituated to television before the study commenced; as such we also hesitate to draw strong conclusions from those data except to observe that those results concord with the suggestion in the main analyses, that there may be no within-individual association amongst Mestizos in this region.

An additional note of caution regarding Study 2 is that the majority of inhabitants in Village C1 viewed television only when travelling. We therefore cannot rule out the possibility that our results are driven by time spent in other locations in general, rather than any television viewed while travelling. The purpose of Study 3, therefore, was to mimic experimentally the impact of television viewing on body ideals in this region.

Study 3 – Experimental manipulation of body weight ideals

There is a strong experimental literature showing that viewing faces or bodies with extreme features (e.g., very high weight or facial distortions) can bias preferences in Western participants (e.g. Boothroyd et al., 2012; Rhodes et al., 2003; see also Introduction above). To date, however, only one study has examined such effects in a non-Western, small-scale society, showing facial adaptation after-effects in the Hadza of Tanzania (Little & Apicella, 2016). Furthermore, to our knowledge, no similar study has ever been conducted in relation to body preferences. Demonstrating such an experimental impact is critical to the argument that visual media is directly changing body preferences across cultures.

In the current study we recruited participants with extremely limited television access from Villages C1 and S1 and examined body weight ideals before or after they viewed a series of high or low weight fashion models. In contrast to Studies 1 and 2, Study 3 used an interactive figure choice paradigm in which participants selected their ideal body by manipulating the apparent BMI of a computergraphic avatar. This allowed us to maximise the sensitivity of our measure, while also using cgi bodies which had been designed to more closely resemble the local population than our British stimuli in Studies 1 and 2. In particular, the test stimuli had skin tones similar to either the local Mestizo or Garifuna population, and included avatars with larger (hourglass shape) or smaller (pearshape shape) breasts because we noted that breasts were not typically of interest in the local population. Similarly, our manipulation stimuli included Latina and Black models, as well as White models, to reflect the mixture of Hollywood and Latin American media that residents of the region tended to consume.

If participants in this low-media environment are indeed susceptible to visual media impacts on ideals, we would predict that those viewing low weight models should show a drop in their weight ideals from pre- to post-test, while those viewing the high weight models (who represent the existing ideal for most Garifuna, but not Mestizo, participants in Study 1) should show static or increasing weight ideals.

Participants

Power analyses based on Boothroyd et al. (2012) (Study 1, partial eta squared .310) indicated that a total of 32 participants (i.e. 16 per condition) would give 95% power to detect a similarly sized interaction between condition and time. We therefore recruited 20 women and 20 men per condition, aged 16 to 78 years (M= 30.4; SD=12.9). Thirty-nine participants (20 men) were from Village C1, where we tested all adults who were willing to participate and older than 16 years old. The remaining 41 (20 men) were recruited from Village S1. Testing took place in 2016 several months after Time 1 data collection for Study 2. All participants provided consent and received $4 in local currency for their time. Participants younger than 18 years old or older than 75 years old were tested with a parent or guardian present. Seven participants from Village S1 who reported having satellite television and watching it in the last 7 days, as well as 2 participants who created the thinnest or fattest ideal body possible at both pre-test and post-test (i.e. showed ceiling/floor effects), were discarded from

analyses, leaving 71 participants in total. Methods and procedures were approved by the Department of Psychology Ethics Committee, reference: 15/09.

Methods

Ideal body size task. Before and after the manipulation, participants completed an interactive Ideal body size test on a laptop. Using the left and right arrow keys, participants manipulated the size of computer-generated but lifelike female figures across a range equivalent to BMI 15 to BMI 40 to create their 'ideal'. The figures were based on 8 'starter' bodies created in the software suite DAZ Studio 4.5 (Figure 4). These bodies varied in shape (pear type vs. hourglass type), skin colour (light vs. dark), and clothing (swimsuit vs. low waist shorts and strapless bra), with each combination of shape/skin colour/clothing being represented. The bodies were presented at an angle of 45^{o} relative to the observer, as this viewing angle allows a finer body size discrimination than front-view (Cornelissen et al., 2018). Assignment of test bodies to pre and post-test was counterbalanced such that half of the participants in each condition received the first 4 bodies at pre-test, and the 4 remaining bodies at post-test, with the other half of the participants receiving the opposite manipulation. Order of presentation within the tests was randomised. Sizes selected for each body were recorded as the percentage of total range by which the chosen size deviated from the midpoint (-50% to 50%).

Figure 4. Sample starter bodies (minimum and maximum size). Upper pair show pear-shaped, dark skinned bodies, in shorts and a crop top. Lower pair show hourglass bodies with light skin in a swimsuit

Each body started at a random size, and the experimenter demonstrated to the participant how the size of the body could be changed using the left and right arrow keys, and showing the full possible range. The participants were then instructed to modify each of the four bodies until these looked like their 'ideal woman body' using the following additional prompts in Creole: 'make a very good body', 'make a perfect body', 'make a body you like plenty, that is sexy' or the Spanish equivalent.

Manipulation phase task. Manipulation stimuli consisted of 144 photographs of either thin (typically UK sizes 4-6) or plus size (UK 16-28) fashion models found on mainstream or specialist UK or U.S. retailers' online catalogues or in popular women's magazines. All images showed women face-on, with a neutral background and with the full body visible (from head to knees at least), in non-sexually explicit poses. Model

ethnicity (White v non-White) and outfit (clothes v swimwear) were balanced across conditions. The photographs were presented in pairs, giving 36 trials per condition, and the participants were instructed to choose which of the two models was their 'favourite'. Within each pair, the models used looked similar and were matched for body shape, type of clothing, and pose. The number of same/different ethnic background pairs was also counterbalanced both within and between experimental conditions. Order of presentation of the pairs and left-right presentation of images were randomised for each participant.

For each pair of photos, the experimenter asked the participant to choose their 'favourite body' between the two, or which one of the two bodies 'looks better, or is a more attractive woman body in your opinion'. Participants chose by tapping on the screen; the experimenter would click on the image, triggering the next trial. This lasted approximately 15 minutes for each participant. Once the manipulation phase was finished, the post-test ideal body task was automatically launched.

Questionnaire. Following the body tests, participants verbally reported on our control variables. Although we targeted participants who had minimal exposure to television, we explicitly asked participants whether they had access to television, and how many hours they had watched in the last 7 days. They also reported the last time that they travelled to other communities (recoded into whether or not they had travelled in the last 7 days), how many hours ago they had last eaten and whether they were trying to lose weight. Finally, we collected anthropometrics to compute the BMI of each participant. Descriptive statistics are given in Table 8.

Analyses. Data were analysed using random intercept models in MLwiN (Rasbash, Charlton, Browne, Healy, & Cameron, 2009) and iterated generalised least squares estimation.

Table 8. Descriptive statistics for all measures in Study 3.

	Whole sample	By groups	
	Mean (SD)	Thin condition	Large condition
Pre-test preference	-9.01 (14.6)	-8.52	-9.51
Post-test preference	-9.42 (14.7)	-5.87	-13.07
Age	30.42 (13.0)	32.53	28.26
Education	5.36 (4.8)	4.94	5.77
Earnings $	1230.07 (2356.2)	1328.35	1137.40
Time since last meal	3.58 (1.8)	3.52	3.64
TV in last 7 days	0.88 (2.2)	1.01	0.74
BMI	24.63 (5.0)	25.26	24.00
% Mestizo	56%	56%	57%
% Travelled	38%	39%	37%
% Dieting	18%	22%	14%

Results

Preliminary analyses showed that the two experimental groups were matched on all variables measured in this study, including age, BMI, dieting, earnings, education, ethnicity, television access and television consumption, time since last meal, sex, and travel (Fs < 1.955, ps > .167). A random intercept model was constructed with participant as the higher level and body as the lower level unit. Initial variance partitioning in a null model indicated that 52.8% of variance operated at the level of the body identity, while the remainder operated at the level of the participant. The intercept was -9.03, which corresponds to a BMI on the interactive scale of approximately 25. Time (pre-test vs. post-test), group and the interaction term between group and time were entered into the model, followed by participant sex and village, and the three-way interaction terms between these two variables and time and group. This final model yielded a significant difference between villages, such that participants in Village S1 preferred thinner bodies in general than those in Village C1, and a significant interaction between group and time (see Table 9 for coefficients, note the main effect of Time indicates the effect of time within the Thin condition, and the interaction term indicates the positive change over time in the Large condition).

As shown in Figure 5, participants in the thin size condition showed a shift towards preferring thinner bodies from pre-test to post-test, while participants in the plus size condition showed the opposite pattern. At post-test, participants' mean body size selected in the plus size condition was significantly larger than in the thin

size condition (mean difference: 7.19, 95% CI 0.38 to 14.00, $t(69) = 2.107$, $p < .05$, $d = .49$). Although the model was somewhat improved by the inclusion of sex and village and their three-way interactions, neither such interaction was significant.

Table 9. Analysis of predictors of ideal body size selected for each starter body. N = 71

	B	*SE*	*ß*	*B*	*SE*	*ß*	*B*	*SE*	*ß*
Constant	-9.19	2.39	0.01	-11.62	2.86	0.01	-7.58	3.15	0.01
Time (ref: pre-test)	-3.56	1.56	-0.01	-3.56	1.56	-0.01	-3.56	1.56	-0.01
Group (ref: thin)	0.66	3.33	0.10	0.52	3.31	0.101	0.57	3.14	0.10
Time*Group	6.21**	2.19	0.09	8.49**	2.7	0.09	10.21**	3.12	0.09
Sex (ref: female)				4.87	3.21	0.10	4.00	3.06	0.08
Sex x Time x Group				-4.32	2.99	0.01	-4.62	2.99	0.01
Location (ref: C1)							-7.69**	3.06	-0.24
Location x Time x Group							-3.31	2.99	0.04
Random effects:									
Individual	151.84	29.16		149.04	28.78		130.34	25.71	
Residual	170.76	10.86		169.96	10.77		169.66	10.72	
Loglikelihood	-2339.38			-2337.61			-2333.1		

Addition of further potential confounding variables (age, BMI, dieting, education, time since last meal, and travel), did not improve the model any further (*p*s for likelihood ratios all > .1), and yielded no other significant main effects. (Ethnicity and earnings were not included because we considered that these were redundant with village and education, respectively.) Furthermore, none of the three-way interaction terms were significant (see Table S4). Finally, we also conducted exploratory analyses including test stimulus body type (colour and body shape combination) and its interaction with the experimental effect. As shown in supplementary Table S3.3, participants selected a larger body as 'ideal' for the lighter-skinned pearshaped stimuli than the darker skinned pear shaped stimuli with the hourglass stimuli of either colour intermediate, but stimulus type did not significantly moderate the main interaction of interest.

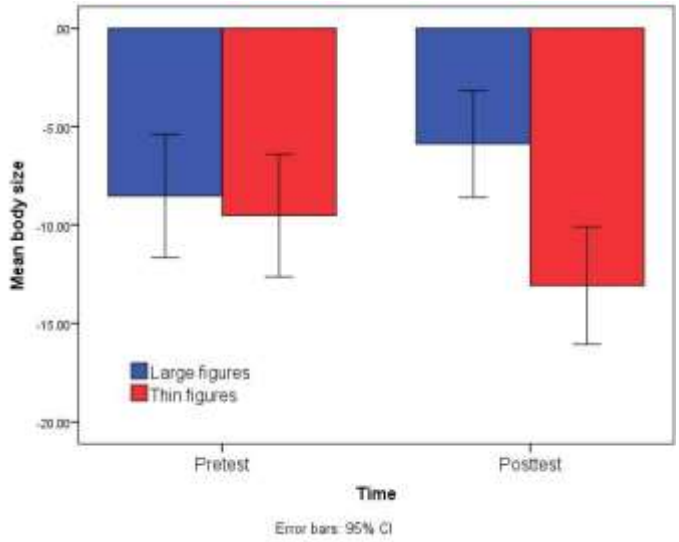

Figure 5. Pre-test to post-test difference in ideal body size between groups

Interim discussion.

Study 3 aimed to mimic experimentally the immediate impact of television exposure on body ideals by presenting a period of visual exposure to images of slim or overweight women. Results showed that just 15 minutes exposure to western media images induced change in participants' perceptions of ideal female body size in the direction of the images seen. These data are consistent with results in Western samples (Boothroyd et al., 2012; Hummel, Rudolf, Untch, Grabhorn, & Mohr, 2012; Stephen, Bickersteth, Mond, Stevenson, & Brooks, 2016; Stephen & Perera, 2014; Winkler & Rhodes, 2005) and suggest that the capacity of visual experience to shape body ideals is not limited to participants with a media-saturated environment. Furthermore,

these data support the hypothesis that the between- and within-individual correlations between TV consumption and body ideals in Studies 1 and 2 do indeed reflect a causal impact of visual media on body preferences.

The fact that none of our potential confounding variables significantly moderated the experimental interaction, suggests that the immediate impact of visual media on body ideals is not reliant on recent prior media exposure or interest in weight loss. Furthermore, although Study 2 main and supplementary analyses suggested that within-individual effects of media may be weak or non-existent in Mestizos in this area, Study 3 showed no difference between Mestizo- and Garifuna-dominant villages.

We did not test how long our experimental effects lasted, but laboratory studies have suggested visual adaptation to face stimuli may have an impact lasting from a few minutes up to a week (Carbon & Ditye, 2011; Carbon et al., 2007; Rhodes, Jeffery, Clifford, & Leopold, 2007). As such we would suggest that it is the continuous exposure to thin female figures in globalised mass media which may be critical in shaping body ideals cross-culturally, rather than simple access itself. However, it is a limitation that although the average participant tested in this study had not left their village for 234 days, most had experienced some television when visiting towns or cities in the past. In other words, although body ideals in low media villages in this location are considerably larger than in the West (Boothroyd et al., 2016), it is theoretically possible that even modest prior experience may modulate the impacts seen here, particularly since familiarity may magnify the impact of exposure effects (Carbon & Ditye, 2011 – although *cf.* Little & Apicella, 2016).

We also note that our stimuli consisted of attractive, high status models in both conditions, and as such we cannot distinguish between 'simple' perceptual visual adaptation and associative learning mechanisms in changing ideals. Given, however, that our intention was to mimic Western visual media exposure in order to establish grounds for a causal relationship, we have nevertheless demonstrated that such media images may indeed directly impact body ideals and as such explain our results in Studies 1 and 2.

General Discussion

A large literature has accumulated which implicates visual culture in promoting a 'thin ideal' for female bodies in Western countries, with experimental laboratory evidence suggesting that both the visual component of visual media, and the evaluative elements, may drive changes in perceptions of attractiveness in viewers (Boothroyd et al., 2012; Jones et al., 2007). While a small number of studies have considered the impacts of Western and/or industrialised cultural influence on perceptions of attractiveness in other cultural settings, these have typically been cross-sectional and involved groups or settings which differ on many more factors than just media exposure. Furthermore, the seminal work on the influence of television on body related psychology in a previously media-naïve population (Becker 2004; Becker et al., 2002), focused on eating disorder risk in young girls and their particular vulnerabilities.

The current studies thus sought to provide the first comprehensive test of the hypothesis that visual media can alter perceptions of female body attractiveness in a non-WEIRD population. Our data show that in an area of low technological development, with a population largely engaged in small scale farming and fishing, those with greater access to and consumption of television have significantly more 'Westernised' body ideals: that is, preferring thinner and curvier female figures. The same was true for those who have likely experienced greater acculturation through time spent in larger towns for education. The association between television consumption and body weight preferences may also be observed within at least one subgroup of individuals who are not already habituated to regular television access. We were also able to experimentally induce change in body weight ideals in individuals from two villages with low television access.

To our knowledge, this is the first time such a detailed comparison of individuals within one region has been attempted, the first controlled experiment of media exposure impacts on body ideals in a non-WEIRD setting, and only the second time that changes in local infrastructure have been utilised to conduct naturalistic experiments on the impact of media on any aspect of body attitudes. Our data also support the suggestion that previous studies showing differences between migrant and non-migrant populations (Mo et al., 2014; Swami & Tovée, 2007; Tovée et al, 2006) may reflect change within individuals in the migrant population following exposure to Western cultural media, rather than pre-existing differences between migrant and non-migrant populations. Indeed, by utilising multiple ethnic groups and multiple quantitative approaches, in particular inclusion of the experimental component, we have yielded the best and clearest evidence to date for a causal role of visual media in shaping body ideals.

Implications and questions for culture and attraction.

These data strongly support the proposal that visual culture may be a critical contributory factor in the development of attraction in modern humans. This then raises the question of to what extent such culturally-driven variation can be documented across domains, beyond just preferences for female body size and shape. The cross-cultural literature on interpersonal attraction is currently taking major steps forward, both in terms of

including previously neglected 'non-WEIRD' populations (e.g. Scott et al., 2014; Sorokowski & Sorokowska et al., 2012) and through large scale international studies of many countries (e.g., Swami et al., 2010: body weight; DeBruine et al., 2010; Marcinkowska et al., 2019; Scott et al., 2014: facial masculinity). These studies increasingly show evidence that preferences seen as robust in Western and industrialised populations may be stronger, considerably weaker, or even absent in other populations. Although variation in body weight preferences has been evident for some time, such patterns are now also being seen in facial attraction research. For instance Scott et al., (2014) found that facial masculinity/femininity preferences are largely absent in small scale societies. In contrast, Little, Apicella and Marlow (2007) found stronger preferences for facial symmetry in Hadza hunter-gatherers than in British participants. Some researchers have started to consider whether cultural factors may influence these patterns in facial preferences, looking at population density and general development levels (Marcinkowska et al., 2019; Scott et al., 2014), as well as internet access (Batres & Perrett, 2014). Our paper provides a strong model of how to further investigate these potential effects in other domains going forward.

An additional question which arises from our study, is whether there are limits to the influence of visual culture. For instance, one might argue that a high weight body ideal may still persist in the most nutritionally stressed environments – that is, the ecological model of preferences may still constrain cultural effects. Our data, however, strongly suggests visual media may be pushing preferences below the healthy optimum in nutritionally vulnerable populations such as ours. If a woman of the BMI most favoured in S2 lost a stone in weight during a bad fish season, she would shift from BMI 22.5 to 19.3 (based on average Nicaraguan female height of approximately 153cm). In contrast our data showed little support for the ecological approach to understanding attractiveness. There was no evidence in Study 1 for a measure of hunger (time since last meal) affecting body weight preferences, which is consistent with our previous in-depth analyses of nutrition and body ideals in this population (Jucker et al., 2017). Furthermore, although supplementary analyses of the full Study 2 dataset showed an increased in preferred BMI during the hungry period, this relationship was only marginal in C1 where we focused our analyses above. As such, it is difficult to conclude that nutritional status impedes any impacts of visual culture. We would suggest, however, that a future study conduct better powered longitudinal tests across known periods of food seasonality and availability, in order to more fully test this question.

At the broadest level, insofar as some theorists have searched for 'universals' in attraction, our data demonstrate that perceptions of female body attractiveness are highly plastic and that this plasticity may be the most striking universal; not only can temporary changes in attractiveness perceptions be induced in the laboratory with Western participants, but such patterns have now been observed in both the short and long term in a 'non-WEIRD' sample.

Considerations for future research

Mobile phones and social media. Future cross-cultural studies may also wish to explore other forms of media access. As discussed above, when our research started, television and radio were the only reliable means of accessing information outside the Pearl Lagoon Basin for the majority of the population. Recently, however, mobile phone infrastructure is improving and where signal exists, those villagers who can afford it are increasingly acquiring smartphones with internet access. Although none of our participants in M2 had smartphones when tested in 2014, by the end of our work in the area, phones were becoming common in that village. Similarly, Village C3 acquired a transmitter in 2016 (after we finished testing there) and now has signal good enough to support streaming of visual media. Just as residents strongly prioritise television access when it is available (for instance, some villagers told us they would sometimes prioritise satellite television subscription over clothes and other personal items or essential repairs to a boat or house), so too someone in the communities with signal will usually have managed to acquire a top-up card recently, and will share their smartphone with fellow villagers.

As discussed, signal is weak and unreliable for downloading/uploading images in most locations, but residents are able to download media (including feature films, music video clips, and a wide range of photos) if they travel to a town and bring it back with them. Furthermore, camera phones allow residents to take photos of each other, which has very recently become a popular trend in village M2. We found that villagers were enthusiastic about being photographed by us and by each other, and could use these pictures to critique their own appearance (there are few or no mirrors that we observed in the villages used in the studies reported above). Younger villagers in particular are also starting to join social networks and seemed to consider the internet more important than television.

Because mobile phones were not present in any of those villages we first tested, we did not include smartphone usage in our participant questionnaire and cannot at this stage say to what extent they may have led us to underestimate media usage in S2 and C3 in particular. A key challenge going forward, therefore, is to consider how accessing the internet and social media may impact more isolated communities, particularly given

the evidence that social media play an increasing role in body dissatisfaction levels amongst young people in the West (Fardouly & Vartanian, 2016).

Timescale effects. Throughout our studies we focused on recent television exposure – either within the last week in Studies 1 and 2, or the immediate effects of experimental exposure in Study 3. This still leaves open the question of how exposure may affect individuals differently over different time courses. Evidence for faces suggests that impacts can last up to 7 days (particularly in familiar stimuli; Carbon & Ditye, 2011) but no data go beyond that timeframe as far as we are aware. At the present time, research on the time course of body adaptation effects is lacking, and studies on repeat-exposure concentrate on explicit training paradigms with accuracy feedback, rather than mimicking cultural exposure patterns (e.g., Gledhill et al, 2016). As such, our data highlight the need to consider further how accumulated exposure may impact perceptions differently over time to more fully understand the mechanisms through which the process of 'visual acculturation' takes place.

Ethnically appropriate stimuli. A key caveat in the current data is that most stimuli were based on either European women (body preference stimuli) or women selected by globalised fashion brands (experimental manipulation stimuli), and even those we constructed specifically to reflect local body shape preferences and skin tones in the experiment still varied principally in BMI. The participants can only choose their ideal from the options we offer, and if their ideal body shape is not present then they cannot choose it. As such we may be missing from our analyses other elements of body shape or composition ideals in these communities. We addressed this issue in a parallel study where participants were able to construct their ideal female body size and shape in 3D avatar software. The results suggested that television access not only predicts a preference for a lower ideal BMI but also a curvier upper female body, consistent with the low BMI, hourglass western ideal (Thornborrow, Jucker, Boothroyd, & Tovée, 2018). As such, our lack of results regarding WCR in the current study may reflect the limitations of our stimuli as well as or instead of participant characteristics.

Male body ideals. Our data focused solely on preferences for women's body weight and shape. It will also be essential in future to examine potential impacts of visual media and cultural change on attitudes to male bodies, especially given the interest in action films and, recently, bodybuilding, we have observed in the area. Indeed, a particular strength of our research, is that we have demonstrated how complementary quantitative methods may be used, alongside long term ethnographic observation, within one study site to comprehensively test hypotheses around cultural influence and/or physical attraction and we highly recommend other researchers adopt this interdisciplinary approach in future.

Body image. Finally, we note that we did not explicitly measure body image in our participants as the focus of the current work was to understand whether media changed body ideals themselves. However, Westernised body weight ideals represent a significant risk factor for body dissatisfaction; particularly since the ubiquity of palm oil and increasing access to refined sugar and processed foods in the region (Jucker et al., 2017) will likely drive population BMI upwards. Indeed, internationally, economic development and increased access to the 'thin ideal' usually coincide with rising levels of obesity, and therefore renders the dominant Western ideal of a slim or underweight female body even more difficult to attain. A key priority for the field of body ideals must therefore be to consider what early-intervention strategies may best reduce any negative impacts of media access on populations undergoing technological transition, while taking into account these populations' priorities, values, and opportunities.

Conclusion

Television is a highly valued asset in the Pearl Lagoon communities. It provides entertainment, increases access to information and political views from inside and outside the region, and facilitates the transmission of vital services such as storm warnings. However, our data suggest that consumption of visual media in the form of television represents a significant driver of changes in local conceptions of female body attractiveness. As such, our findings support the hypothesis that perceptions of attractiveness are inherently plastic, subject to cultural influence, and that mass media may be propagating and reinforcing Western beauty ideals around the world. We strongly recommend i. that further research be undertaken into other aspects of attraction which may be susceptible to such changes (such as body ideals in men and skin colour preferences); ii. that replications are conducted in other communities; and iii. that researchers and local communities come together to consider whether, and how, early intervention should be attempted.

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